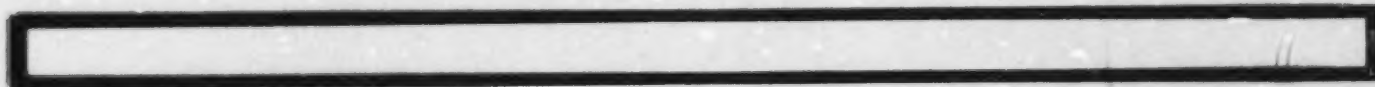


Leeches (Annelida: Hirudinea)
Found in North American Mollusks

(U.S.) Environmental Monitoring and
Support Lab.-Cincinnati, OH

1976



U.S. Department of Commerce
National Technical Information Service

NTIS

TECHNICAL REPORT DATA
(Please read instructions on the reverse before completing)

1. REPORT NO. EPA-600/J-76-104		2. Journal Article		3. REC PB80-202344	
4. TITLE AND SUBTITLE Leeches (Annelida:Hirudinea) Found in North American Mollusks				5. REPORT DATE 1976	
				6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S) Donald J. Klemm				8. PERFORMING ORGANIZATION REPORT NO.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring and Support Lab., - Cin., OH Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268				10. PROGRAM ELEMENT NO.	
				11. CONTRACT/GRANT NO.	
12. SPONSORING AGENCY NAME AND ADDRESS Same as above				13. TYPE OF REPORT AND PERIOD COVERED	
				14. SPONSORING AGENCY CODE EPA-600/06	
15. SUPPLEMENTARY NOTES Journal of Malacological Review, 1976, Vol. 9, pages 63-76					
16. ABSTRACT Aquatic leeches are important as parasites and predators of many groups of animals. Eleven species are reported living in North American snails and clams, 7 of which are known to behave as parasites, 2 are assumed to be parasitic, and the other 2 are not parasitic. In this paper these leeches are listed, a key is provided to the species, their known molluscan hosts are indicated, and aspects of their taxonomy are discussed.					
REPRODUCED BY NATIONAL TECHNICAL INFORMATION SERVICE U. S. DEPARTMENT OF COMMERCE SPRINGFIELD, VA. 22161					
17. KEY WORDS AND DOCUMENT ANALYSIS					
a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS		c. COSATI Field/Group	
Leeches Invertebrates Annelida Ecology Parasites Mollusca Clams Gastropoda Mussels Pelecypoda Snails Taxonomy		North America Hirudinea Geographical Distribution Predators Hosts		06/C	
18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC		19. SECURITY CLASS (This Report) UNCLASSIFIED		21. NO. OF PAGES 16	
		20. SECURITY CLASS (This page) UNCLASSIFIED		22. PRICE	

LEECHES (ANNELIDA: HIRUDINEA) FOUND IN NORTH AMERICAN MOLLUSKS

Donald J. Klemm¹

ABSTRACT

Aquatic leeches are important as parasites and predators of many groups of animals. Eleven species are reported living in North American snails and clams, 7 of which are known to behave as parasites, 2 are assumed to be parasitic, and the other 2 are not parasitic. In this paper these leeches are listed, a key is provided to the species, their known molluscan hosts are indicated, and aspects of their taxonomy are discussed.

Aquatic leeches are usually predators or parasites, and some have medical importance in that they serve as 1st and 2nd intermediate hosts, or as final hosts, of parasitic protozoans, trematodes, cestodes, nematodes and nematomorphs. In spite of the importance of leeches, knowledge of their ecology, distribution and taxonomy is wanting. One important aspect of the ecology of leeches is that their abundance and distribution appears to be regulated principally by the availability of food organisms. However, the diets of many species are unknown, inadequately reported, or appear questionable in light of recent studies by Soós (1969), Sawyer (1972) and Klemm (1975).

The feeding behavior of leeches is generally accepted as a form of predation. Nevertheless, their trophic level, i.e., whether they are predators, parasites or scavengers, is difficult to determine for many species. Past studies have indicated that most leeches are not host-specific but tend to restrict their diets to certain animal groups (e.g., insects, crustaceans, annelids, mollusks, frogs, salamanders, turtles, fishes, birds or mammals). J. P. Moore (1939) indicated that most of the smaller species of Glossiphoniidae are habitually malacophagous and that they feed almost exclusively on aquatic snails. Yet, in the family Glossiphoniidae in North America, only species of *Glossiphonia*, *Helobdella* and *Marvinmeyeria* are known to feed on mollusks, and some interesting snail-host preferences have been reported (J. E. Moore, 1964; Sarah, 1971; Klemm, 1973, 1975).

Species in the genera *Glossiphonia*, *Helobdella* and *Marvinmeyeria* have a proboscis which aids in sucking blood. In the sanguivorous process, not only all the body fluids of the snail host may be devoured, but also the tissues of the animal as well. This behavior can be considered as predation. Nevertheless, young individuals of some species may live for awhile inside their molluscan hosts, taking only an occasional blood meal (Wilkialis, 1964; Gruffydd, 1965; Hatto, 1968; Sarah, 1971; Klemm, 1972a, 1973, 1975). This mode of nutrition can be termed parasitism.

The distribution of Glossiphoniidae is nearly world-wide and the family includes 22 genera, approximately 140 nominal species and several subspecies (Soós, 1966, 1969, 1970). The zoogeography of the species varies, some being common and cosmopolitan, while others are rare and have restricted distributions (see Soós, 1969, 1970 for distribution world-wide and Klemm, 1972b; Sawyer, 1972; Davies, 1973 for North America). Some species are endemic to 1 locality, and others appear

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restricted to 1 particular type of habitat. Most data on their distribution, however, are quite incomplete since many regions of the world have not been sampled adequately.

The present account contains new and more precise information (Table 1) on the diets of glossiphoniid leeches that feed primarily on mollusks, discusses aspects of leech taxonomy, and presents a taxonomic key to the leeches known from North American mollusks.

Two main glossiphoniid genera in North America, *Glossiphonia* and *Helobdella*, include species known to feed on mollusks (J. E. Moore, 1964; Sarah, 1971; Sawyer, 1972; Klemm, 1972a, 1973, 1975) and on other invertebrates (Klemm, 1972a, 1975; Sawyer, 1972).

Glossiphonia is represented in North America by 3 widely distributed species, *G. complanata*, *G. heteroclita* and *G. swampina*, and 1 subspecies, *G. complanata mollissima* (J. P. Moore, 1898; Pinto, 1923; J. P. Moore and Meyer, 1951; Klemm, 1972b; Sawyer, 1972, 1973). *G. complanata* and *G. heteroclita* also occur throughout Eurasia (Soós, 1966, 1969), while *G. swampina* is presently known only from the Carolinas in North America. The subspecies, *G. complanata mollissima*, is reported from Alaska (Bering and Kodiak Islands) by J. P. Moore (1898), Pinto (1923) and J. P. Moore & Meyer (1951). This questionable geographical subspecies is currently thought to be merely a color variant of *G. complanata* (Autrum, 1936; Sawyer, 1972).

Glossiphonia complanata is common in North America and is predominately a predator of mollusks (Klemm, 1975), although it has been reported by various authors to feed occasionally on other invertebrates. *G. heteroclita* is considered to be rare in North America (Klemm, 1972a, 1972b, 1975; Sawyer, 1972; Davies, 1973), but it probably is frequently overlooked because of its small size and inconspicuous coloration. In Europe, it has been reported to feed on various snails (e.g., Guibe, 1936; Gruffydd, 1965; Hatto, 1968). In North America, Klemm (1975) found it parasitizing the snail *Physa gyrina*, its only known host in the New World.

The rediscovery of another rare leech, *Glossiphonia swampina*, by Sawyer (1973) in the Coastal Plain of South Carolina and by Sawyer (pers. comm.) in North Carolina extends the range of the *heteroclita-swampina* complex in North America. The arrangement of the 3 pairs of eyes of *G. swampina* resembles that of *G. heteroclita*; however, *G. swampina* differs from *G. heteroclita* in having 4 to 7 mid-dorsal, irregular, transverse bars composed of small, blackish chromatophores. Also, *G. heteroclita* is reported to be a northern species (Sawyer, 1973), known only as far south as northwestern Pennsylvania (J. P. Moore, 1906) and northern Indiana (J. P. Moore, 1920). Extensive collecting from states with poorly known leech representation could extend the range of both. Sawyer (1972) also disclosed that generally the body of *G. heteroclita* is whitish and usually devoid of pigment, but that some specimens have 1 to 6 inconspicuous, fine, black chromatophores in sparse clusters situated metamerically from the cephalic end to the anal region, especially along the mid-dorsal line and along the margins of the posterior part of the body. Many specimens collected in benthic samples from the Great Lakes region have a dark to light brownish-black, solid or irregular, median stripe extending from the cephalic region posteriorly. Also this pigmented stripe is sometimes interrupted. The dorsum may or may not bear inconspicuous brownish-black chromatophores in sparse clusters, especially in the posterior part of the body, including margins. Sawyer (1973) recommended that a more detailed morphological comparison of these 2 species is needed but that in the interim Bosc's (1802) *G. swampina* should be recognized as a valid species. Nonetheless, the taxon may belong in a disjunct population of a color variant of *G. heteroclita* or a very close species (J. P. Moore, 1952). Its feeding behavior is unknown, but the close morphological resemblance

of *G. swampina* to *G. heteroclita* suggests that its food preference may be snails.

The distribution of *Helobdella* is world-wide and many of the species prey upon freshwater invertebrates, some preferring mollusks. Apparently this genus has its center of distribution in South America (Sawyer, 1972), since more than 21 species and subspecies are known from Central and South America (Weber, 1913, 1915; Pinto, 1923; Autrum, 1936; Cordero, 1937; Ringuelet, 1943, 1944a, 1944b, 1945). Of the 29 species and several subspecies in this genus reported by Soós (1969) for the world, only 7 are known from North America (J. P. Moore, 1959; Klemm, 1972a, 1972b, 1975; Sawyer, 1972).

The validity of a number of *Helobdella* species remains uncertain. In the New World, some species names are in doubt because of the problem of polymorphism commonly observed in the *H. triserialis* complex in South America and the *H. fusca* complex in North America. The occurrence of intergrades and the variability in the degree of sensillae, papillation and pigmentation from one locality to another has caused some of the taxonomic confusion. Ringuelet (1943, 1944a, 1944b, 1945) examined many of the South American *Helobdella* and recognized 17 species and 5 subspecies of *H. triserialis*, of which at least 1, *H. triserialis lineata*, clearly belongs to the *fusca* group in North America (J. P. Moore, 1901; Sawyer, 1967, 1972). Ringuelet (1943) also regarded *H. lineata* as a variety of 1 extremely variable and widely distributed species, *H. triserialis*. J. P. Moore (1906) examined the *fusca* group and distinguished 3 varieties, *fusca*, *lineata* and *papillata*. At first he believed that these forms were probably connected by an overlap of morphological characters, but later he (1952, 1959) recognized each of these as distinct species. Of the 3 species, *H. papillata*, *H. lineata* and *H. fusca*, the last 2 are considered the most variable.

Sawyer (1972) in his critical review of North American *Helobdella* indicated that in some published records *H. fusca* is confused with *H. lineata*. Typically, *H. fusca* lacks dorsal papillae (Castle, 1900) and has longitudinal white stripes, alternating with coffee-brown stripes and/or lines, but lacks a transverse pattern. Also, *H. fusca* may have small metameric white spots in the anal region, resembling those found on *H. lineata*. The latter, on the other hand, has few, scattered or 3 series of black-tipped papillae, with or without longitudinal stripes, lines and 6 or fewer series of roundish metameric white spots. These spots are sometimes variable and may disappear in preserved specimens. Occasionally, in specimens in which the papillae are absent and the color uniform, *H. lineata* may be distinguished from *H. fusca* by the series of metameric white spots on the dorsum instead of the continuous longitudinal stripes. On very rare occasions, some specimens of the 2 species may be difficult to separate. *H. papillata*, on the other hand, is easy to identify by its numerous large papillae (arranged in 5, 7 or 9 longitudinal rows) that protrude from the dorsum.

On the bases of the arrangement of chromatophores, sensillae, and the presence of small papillae, J. P. Moore (1939) described a 4th related species, *Helobdella punctatolineata*. This species occurs commonly in Puerto Rico (J. P. Moore, 1939) and in the Dominican Republic (Klemm, unpubl.). Several reports of the species in the United States (Sapikarev, 1968; Klemm, 1972b; Richmond, 1972) remain questionable. However, specimens which closely resemble this species have been found recently from southern Lake Michigan (Klemm, unpubl.). Additional collecting may extend the known range of *H. punctatolineata*, or experimentation may demonstrate that individuals which resemble this species in North America are, in fact, a color variant of either the polymorphic *H. fusca* or *H. lineata*.

I have found the intensity and longitudinal arrangement of the brown or gray chromatophores to vary in some adult and young specimens collected from Puerto Rico and the Dominican Republic. Typically, the dorsum in both live and preserved adult

TABLE 1. Hosts cited in the literature of leeches (Glossiphoniidae) feeding on North American mollusks (including hosts reported in other regions of the world).¹

Hosts	Leech genera & species	Leech distribution
Mollusks, Oligochaetes, Insect larvae	<i>Glossiphonia</i>	World-wide
Mollusks:	<i>G. complanata</i>	Cosmopolitan, Holarctic Region, (Argentina ?), Europe, North America, India, Zaire
<i>Ancylus fluviatilis</i> <i>Bithynia tentaculata</i> <i>Gyraulus parvus</i> <i>Helisoma anceps</i> <i>Helisoma campanulatum</i> <i>Helisoma trivolvis</i> <i>Hydrobia jenkinsi</i> <i>Lampsilis siliquoidea</i> <i>Lymnaea stagnalis</i> <i>Promenetus exacuus</i> <i>Physa fontinalis</i> <i>Physa gyrina</i> <i>Physa heterostrophia</i> <i>Physa integra</i> <i>Planorbis corneus</i> <i>Planorbis vortex</i> <i>Pisidium</i> sp. <i>Sphaerium simile</i> <i>Sphaerium transversum</i> <i>Stagnicola reflexa</i>		
Snails:	<i>G. heteroclita</i>	Holarctic Region, Europe, North America, India, Cen- tral and East Africa
<i>Ancylus</i> sp. <i>Bithynia tentaculata</i> <i>Enchytracus albidus</i> <i>Leptolimnaea glabra</i> <i>Lymnaea stagnalis</i> <i>Pachylabura maura</i> <i>Physa fontinalis</i> <i>Physa gyrina</i> <i>Physa heterostrophia</i> <i>Planorbis contortus</i> <i>Planorbis corneus</i> <i>Planorbis nitidus</i> <i>Planorbis umbilicatus</i> <i>Radix pereger</i>		
Snails (unknown)	<i>G. swampina</i>	U. S. A. (North Carolina, South Carolina)
Mollusks, Oligochaetes, Insect larvae, Crustaceans	<i>Helobdella</i>	World-wide
Oligochaetes, Insect larvae, Snails (?)	<i>H. elongata</i>	North America

TABLE 1. (Cont.)

Hosts	Leech genera & species	Leech distribution
Mollusks: <i>Australorbis glabratus</i> <i>Helisoma anceps</i> <i>Helisoma campanulatum</i> <i>Helisoma trivolvis</i> <i>Lymnaea stagnalis</i> <i>Promenetus exacuus</i> <i>Physa gyrina</i> <i>Physa integra</i> <i>Physa parkeri</i> <i>Pisidium virginicum</i> <i>Stagnicola reflexa</i>	<i>H. fusca</i>	North, Central, South America
Snails: <i>Helisoma anceps</i> <i>Helisoma campanulatum</i> <i>Helisoma trivolvis</i> <i>Physa gyrina</i>	<i>H. lineata</i>	North, Central, South America
Snails: <i>Bulinnea megasoma</i> <i>Cyraululus parvus</i> <i>Helisoma anceps</i> <i>Helisoma campanulatum</i> <i>Helisoma trivolvis</i> <i>Physa gyrina</i> <i>Physa parkeri</i> <i>Stagnicola elodes</i>	<i>H. papillata</i>	Northern North America
Snails: <i>Australorbis glabratus</i> <i>Planorbis corneus</i> <i>Stenophysa marmorata</i>	<i>H. punctatolineata</i>	Puerto Rico, Dominican Republic, U. S. A. (?)
Oligochaetes, Insect larvae, Crustaceans, Mollusks (?)	<i>H. stagnalis</i>	Cosmopolitan, except Australia
Mollusks (highly doubtful): <i>Cincinnatia emarginata</i> <i>Promenetus exacuus</i> <i>Physa gyrina</i> <i>Physa integra</i> <i>Planorbis albus</i> <i>Pisidium</i> sp. <i>Sphaerium transversum</i> <i>Stagnicola reflexa</i>		

TABLE 1. (Cont.)

Hosts	Leech genera & species	Leech distribution
Snails (unknown)	<i>H. transversa</i>	U.S.A. (Southern Michigan)
Snails:	<i>Marvinmeyeria</i>	North America
<i>Aplexa hypnorum</i>	<i>M. lucida</i>	Northern North America
<i>Gyraulus parvus</i>		
<i>Helisoma trivolvis</i>		
<i>Physa gyrina</i>		
<i>Physa heterostrophia</i>		
<i>Planorbula armigera</i>		
<i>Promenetus exacuus</i>		
<i>Stagnicola elodes</i>		
<i>Stagnicola emarginata</i>		
<i>Stagnicola exilis</i>		

¹From Klemm, 1974.

and young bears longitudinal brown or gray lines (singly and doubly arranged) and 4 to 6 transverse rows of white spots (sensillae) on every sensory annulus, giving an effect of alternating longitudinal light and dark lines. In some individuals the intensity and distribution of the brown or gray pigments vary. In most specimens a median stripe extends from the eyes to the anus. It is darker than the other longitudinal lines and the pigmentation tends to be concentrated at the margins of the stripe leaving the middle paler. In some instances, the demarcation is so obvious that the median stripe appears divided into a pair of brown to gray lines. On the sensory annuli of most specimens, a series of 4 to 6 white spots extends transversely over the entire body. The median spots are the largest and are lateral to the median stripe. Posteriorly they expand into roundish spots. In both live and preserved specimens of some adults and young, the white spots may be variable or missing. Usually the dorsum of the sensory annulus of each somite contains a few small but somewhat staggered distinct papillae. Those on the median stripe are the largest and usually tipped with black pigment. Occasionally, on some individuals, the papillae are barely visible or not discernable.

Sawyer (1972) added yet a 5th species, *Helobdella transversa*, which he collected from southern Michigan. Its description is based primarily on the arrangement of the transverse rusty-brown and alternating metameric white bands, which consist of 8 to 10 slightly raised white spots in various states of confluence. In contrast to *H. fusca*, *H. transversa* has no longitudinal pattern of white and brown stripes.

Based on the interpretation of Soós (1969), Davies (1971) relegated *Helobdella fusca* and *H. lineata* to the synonymy of *H. triserialis*. *H. papillata*, however, was retained as a distinct species (Soós, 1969). Klemm (1972a, 1972b, 1975) and Sawyer (1972) have often collected *H. fusca*, *H. lineata* and *H. papillata*, and consider these 3 to be consistently recognizable forms (i.e., distinct species). In addition, Sawyer (1972) found 2 questionable forms of *H. fusca* (one being a whitish form lacking pigmentation and the other being a mottled form, pigmented with irregularly

spaced whitish blotches on a brownish background and with no longitudinal stripes or bands). Until the problem of polymorphism in the *fusca* complex is settled by laboratory rearing, the names for the American *Helobdella* will not be finally settled. Therefore, in this paper the nomenclature of J. P. Moore (1959) is followed.

Further, an important problem with respect to the family Glossiphoniidae and the genus *Helobdella* is the insufficient amount of distributional data and the lack of well-defined species characters for some of the common as well as the poorly known forms. Until better taxonomic characters are established by a detailed study of the anatomical features, the status of several *Helobdella* species will remain questionable. In North America, this is especially true for the *fusca* complex in which the variability of the papillae, sensillae and arrangement of the chromatophores causes confusion. Also, the clarification of taxonomic and zoogeographical problems in *Helobdella* and in some of the other genera of leeches is hampered by the lack of comparative ontogenetical, embryological and genetic studies (Soós, 1970). A number of species currently recognized almost exclusively on their external morphological features may have been incorrectly classified.

Helobdella fusca, *H. lineata*, *H. papillata* and *H. punctatolineata* have been reported to feed primarily on mollusks (e.g., J. P. Moore, 1939; Harry & Aldrich, 1958; McAnnally & D. V. Moore, 1966; Sarah, 1971; Klemm, 1972a, 1975; Sawyer, 1972). The feeding habit of *H. transversa* is unknown (Sawyer, 1972), but since the animal is closely related morphologically to the above species, it may also be malacophagous.

Two other species of Glossiphoniidae, *Helobdella elongata* and *H. stagnalis*, have poorly known feeding requirements, and their feeding on mollusks is doubtful (Sawyer, 1972; Klemm, 1975). *H. stagnalis* is the only North American species of leech with a brown chitinous scute in the anterior region. On rare occasions when the scute is missing, the species might be confused with *H. elongata*. Posteriorly, *H. stagnalis* is relatively wider than *H. elongata*, whose body has a cylindrical worm-like appearance and whose body margins are nearly parallel. *H. stagnalis* has 6 pairs of crop caeca, whereas *H. elongata* has only 1 pair.

Marvinmeyeria [= *Oculobdella*] (also Glossiphoniidae) is represented in North America by 1 species, *M. lucida*. Soós (1969) erected the genus *Marvinmeyeria* based on the configuration of the posterior end of its reproductive organs, which differ from those in the type species, *Oculobdella socimulcensis* Caballero 1931 (known only from Mexico). Meyer & J. P. Moore (1954) had indicated that a new genus would probably have to be established for *M. lucida*. This poorly known species is often encountered in woodland pools and temporary or semipermanent bodies of water in Michigan (Sawyer, 1968, 1972; Klemm, 1972a, 1973, 1975) and in various habitats in Canada (Meyer & J. P. Moore, 1954; J. E. Moore, 1964, 1966; Davies, 1973). *M. lucida* feeds only on snails (J. E. Moore, 1964; Klemm, 1972a, 1973, 1975). In adult and young specimens, the dorsal and ventral surfaces are heavily pigmented with uniform blackish-gray chromatophores and with thin, dark, paramedial lines prevalent in the anterior region. On a few occasions young were observed to be uniformly white and lacking the dusky, blackish-gray pigments.

Another glossiphoniid species, *Placobdella montifera*, has been recorded in mussels (J. P. Moore, 1912) and has been reported by various authors to feed on or attach to other invertebrates, amphibians and fishes. However, the only confirmed host records have been from a variety of fishes (Ryerson, 1915; Pearse, 1924; Bere, 1931; Bangham, 1933; Bangham & Hunter, 1939; Harms, 1959, 1960; Hoffman, 1967; Poe, 1972; Richmond, 1972; Klemm, unpubl.). Reports of its feeding on mussels are doubtful; hence, the species is not included in this study, but it

can be identified by using one of several other keys (J. P. Moore, 1959; Davies, 1971; Klemm, 1972b; Sawyer, 1972). Wilson & Clark (1912) and Coker *et al.* (1921) also found leeches in mussels (i.e., in the mantle cavity) and believed they ate the mussel's mucus. Some leeches are often found attached to both vacant and occupied shells of mussels, but they probably use the shells only as a substrate for attachment.

The leeches in this paper, i.e., those found associated with freshwater mollusks, can be identified by a number of features. The key which follows was constructed from characters observed in living and preserved specimens, both young and adult, and includes their known distributions. In regard to *Helobdella fusca*, *H. lineata* and *H. punctatolineata*, some allowances should be made for morphological variability when using the key.

Key to leeches found in North American mollusks

- 1a. Eyes 1 pair, always separated (Fig. 1) 2
 1b. Eyes 3 pairs (Fig. 2a,b). Genus *Glossiphonia* 9



Fig. 1



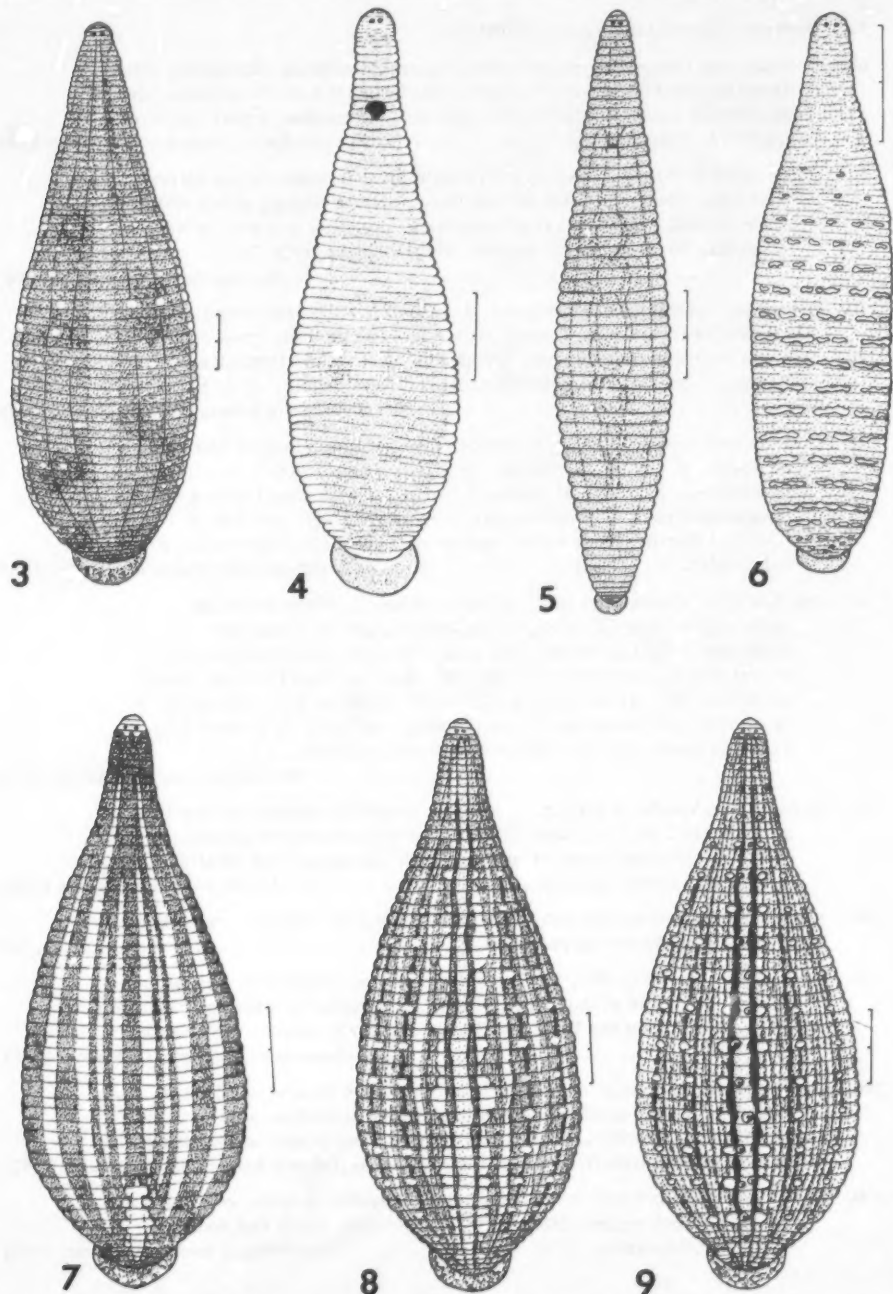
Fig. 2a



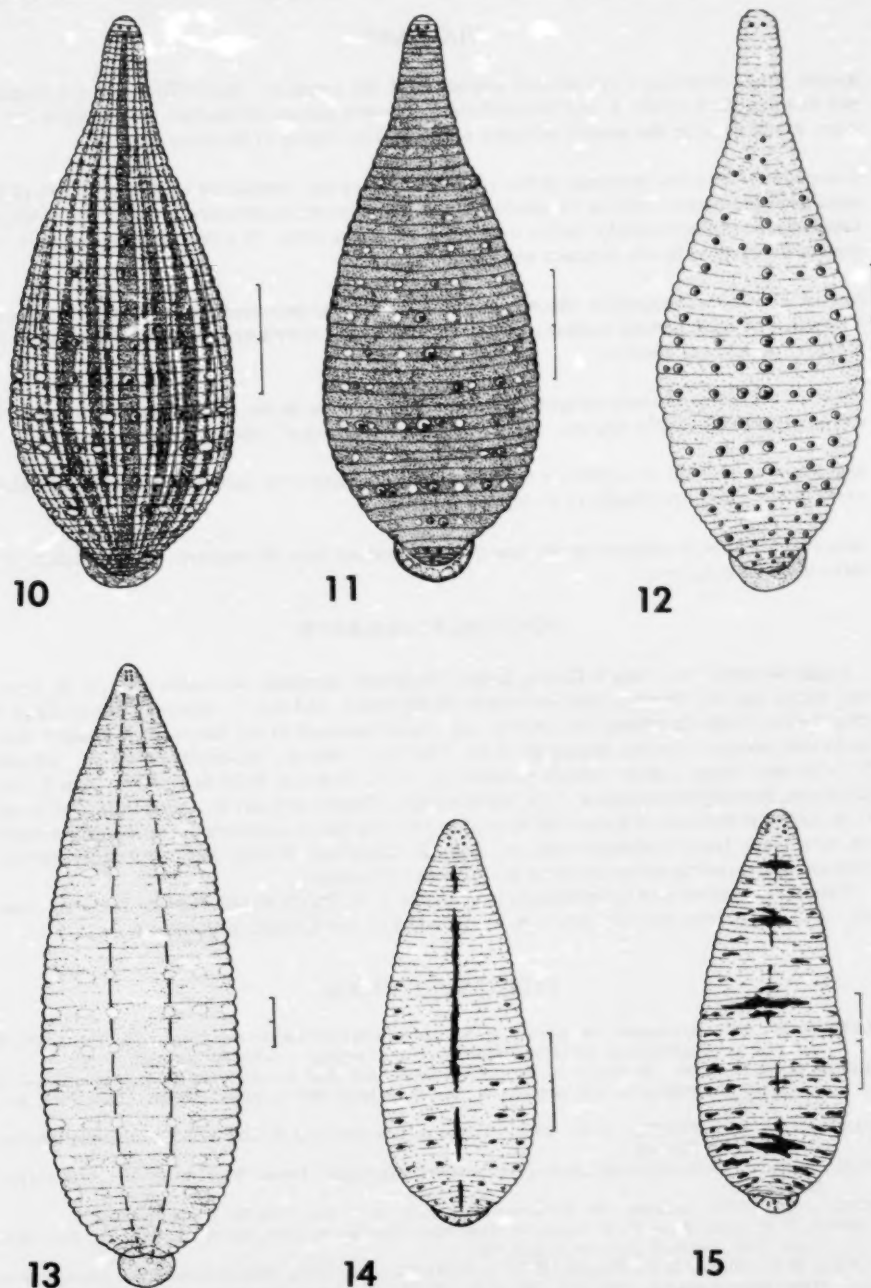
Fig. 2b

- 2a. Dorsum unpigmented, uniformly pigmented, or pigmented with longitudinal or transverse bands, lines or stripes and with or without metameric whitish spots (sensillae) on every 3rd annulus in middle of body region; heavily to sparsely or not papillated, or with a chitinous scute (nuchal plate) in anterior region; gonopores separated by at least 1 annulus. Genus *Helobdella* 3
- 2b. Dorsal and ventral surfaces heavily pigmented with uniform, minute, blackish chromatophores, with thin dark paramedial lines extending into anterior region; dorsal surface smooth, no papillae or scute; gonopores united; uncommon, but locally abundant in northern North America. (Fig. 3) *Marvinmeyeria* [= *Oculobdella*] *lucida* (Moore 1954)
- 3a. Without a chitinous scute in the anterior region 4
- 3b. With a chitinous scute on dorsum in the anterior region; cosmopolitan. (Fig. 4) *Helobdella stagnalis* (Linnaeus 1758)
- 4a. Dorsum smooth, without papillae 5
- 4b. Dorsum with papillae (few, scattered, or arranged in 3 to 9 longitudinal rows on neural annuli) 8
- 5a. Body pigmented, with or without longitudinal or transverse bands, lines and/or stripes; body flat; usually 6 pairs of crop caeca 6
- 5b. Body unpigmented, elongate and subcylindrical; lateral margins of body almost parallel, body smoothly round; posterior sucker small, terminal; translucent; 1 pair of crop caeca; uncommon, but locally abundant in North America. (Fig. 5) *Helobdella elongata* (Castle 1900)

- 6a. Dorsum without transverse pigmentation 7
- 6b. Dorsum with transverse rusty-brown, interrupted bands alternating with irregular whitish bands, the latter consisting of 8 to 10 confluent white metameric spots on each neural annulus; uncommon, known only from southern Michigan. (Fig. 6) *Helobdella transversa* Sawyer 1972
- 7a. Color uniform coffee-brown or with longitudinal whitish stripes alternating with coffee-brown stripes and/or lines; with or without small whitish spots in anal region; a variable species; common in northern North America, occurs also in southern United States. (Fig. 7) *Helobdella fusca* (Castle 1900)
- 7b. Dorsal pigmentation brown or gray, arranged in numerous longitudinal stripes or lines; neural annuli with 4 to 6 longitudinal rows of whitish spots over entire body; common in Puerto Rico and Dominican Republic, occurrence in North America questionable. (Fig. 8) *Helobdella punctatolineata* Moore 1939
- 8a. Dorsum with sparse, small, brown to black papillae, largest and most numerous on the median stripe; pigmentation brown or gray, arranged in numerous longitudinal stripes or lines; neural annuli with 4 to 6 longitudinal rows of whitish spots over entire body; common in Puerto Rico and Dominican Republic, occurrence in North America questionable. (Fig. 9) *Helobdella punctatolineata* Moore 1939
- 8b. Dorsum with 3 rows (typically) or fewer of small, black-tipped or uniformly pale papillae; pigmentation arranged in numerous longitudinal light and dark lines and/or stripes; whitish spots on neural annuli, unaligned or if aligned, then confined to areas lateral to papillae (Fig. 10) or color uniform with papillae few, scattered, or in 3 rows; whitish spots on neural annuli unaligned or aligned (Fig. 11); a variable species; common in North America *Helobdella lineata* (Verrill 1874)
- 8c. Dorsum rough, with many large, whitish, rounded conspicuous papillae, arranged in 5 to 7 or 9 longitudinal rows on each neural annulus; dorsum yellowish-brown or unpigmented; uncommon but locally abundant in North America. (Fig. 12) *Helobdella papillata* (Moore 1906)
- 9a. Eyes in an approximately triangular pattern, the 1st pair always closer than the 2 posterior pairs (Fig. 2a) 10
- 9b. Eyes equidistant (Fig. 2b), in 2 paramedian rows; papillae in 6 longitudinal rows; with a pair of dark brown lines, interrupted by pale spots dorsally and ventrally, but the lines may be absent; body opaque; very common. (Fig. 13) *Glossiphonia complanata* (Linnaeus 1758)
- 10a. Body smooth; pigmentation slight, brownish-black in sparse clusters, and often with a dark median, longitudinal stripe (sometimes interrupted) on dorsum, but without paired lines; body translucent; uncommon in northern North America. (Fig. 14) *Glossiphonia heteroclita* (Linnaeus 1761)
- 10b. Body smooth; 4 to 7 mid-dorsal irregular, transverse bars, composed of brownish-black pigmentation; body translucent; North and South Carolina, uncommon. (Fig. 15) *Glossiphonia swampina* (Bosc 1802)



FIGS. 3-9. Leeches of freshwater mollusks. FIG. 3. *Marvinmeyera lucida*. FIG. 4. *Helobdella stagnalis*. FIG. 5. *H. elongata*. FIG. 6. *H. transversa* (after Sawyer, 1972). FIG. 7. *H. fusca*. FIG. 8. *H. punctatolineata*. FIG. 9. *H. punctatolineata*. Scale lines = 2 mm.



FIGS. 10-15. Leeches of freshwater mollusks. FIG. 10. *Helobdella lineata*. FIG. 11. *H. lineata*. FIG. 12. *H. papillata*. FIG. 13. *Glossiphonia complanata*. FIG. 14. *G. heteroclita*. FIG. 15. *G. swampina*. Scale lines = 2 mm.

GLOSSARY

Annuli (sing. *Annulus*) - superficial segments of the somites. Basically there are 3 annuli per somite, each of which may be subdivided in some genera of leeches. Annulation can be most easily seen in the lateral margins of the middle region of the body.

Gonopores - external openings of the reproductive tracts, located on or in the furrow of the annulus on the ventral surface of somite XI and XII. The male gonopore is anterior to, larger than and more conspicuously visible than the female gonopore. In a few species the male and female ducts open into a common gonopore.

Neural Annulus - the annulus which contains the sensillae (segmental receptors). Since only 1 annulus of each somite contains sensillae, the neural annuli are a convenient outward indication of the true somite.

Papillae - protrusible sense organs scattered or in a series on the dorsal surface of the leech and thought to be tactile organs. (In some keys "tubercules" represent large papillae.)

Sensillae (segmental receptors) - whitish rounded metameric spots on neural annuli which contain cells that are thought to be light-sensitive.

Somite - a true body segment or metamere. All leeches have 34 somites, each of which contains a nerve ganglion.

ACKNOWLEDGEMENTS

I wish to thank Drs. John I. Bruce, Lowell Technical Institute, Massachusetts, J. B. Burch and Henry van der Schalie, The University of Michigan, and Roy T. Sawyer, The College of Charleston, South Carolina, for advice and encouragement of my interests in aquatic mollusks and leeches. Special thanks go to Dr. Marvin C. Meyer, University of Maine, and Jarl K. Hiltunen, Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service, Ann Arbor, Michigan, for helpful comments on the manuscript. Thanks are due Dr. Marian H. Pettibone, U.S. National Museum of Natural History, for allowing me to examine the Smithsonian Institution's large leech collection and Dr. John D. Unzicker, Illinois Natural History Survey, Urbana, for allowing me to examine the Illinois collection.

This investigation was supported (in part) by the U.S. Public Health Service Training Grant No. 5 T1 AI 41 from the National Institute of Allergy and Infectious Diseases.

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